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PARTIAL INFERTILITY BETWEEN TWO MEMBERS OF THE *PEROMYSCUS TRUEI* GROUP OF MICE

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In this paper there is described the occurrence of partial infertility between two closely related taxonomic forms, *Peromyscus truei truei* (Shufeldt) and *P. nasutus griseus* Benson. These species are both placed by Osgood (1909: 30) in the *P. truei* group, and they are therefore closely related.

The stock of *Peromyscus nasutus griseus* used in this study is from the black lava of the Tularosa Malpais near Carrizozo, Lincoln County, New Mexico. The parents of the stock were secured in part by G. W. Bradt and in part by Seth B. Benson.

Three stocks of the pinyon mouse, *Peromyscus t. truei,* were employed. The Mesa de Maya stock was secured on the north side of the Mesa de Maya, Las Animas County, Colorado, about 45 miles east of Trinidad, by an expedition supported jointly by the Museum of Zoology, University of Michigan, and the Carnegie Institution of Washington. The Highrolls stock is from near Highrolls, Otero County, New Mexico, and was taken by the University of Michigan-Walker-Harris Expedition of 1927. The Deadman Flat stock was taken on Deadman Flat, about 17 miles north of Flagstaff, in Coconino County, Arizona, by G. W. Bradt and assistants, while on an expedition which was supported in part by the Carnegie Institution of Washington.

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All the matings have been made by placing a single female and a single male together in a cage.

The several members of each stock of *truei* have shown a considerable degree of fertility when mated with other members of the same stock. Of 35 matings which were maintained 2 months or more between members of the Mesa de Maya stock, 17 matings, or about one-half, produced young. In the Deadman Flat stock 14 matings out of 32 have been successful. The Highrolls stock has been less fertile, for in 45 matings only 9 pairs produced young. It is possible, however, that some individuals included in the Highrolls stock may actually have been *nasutus,* though all the mice which bred were *truei.*

The *griseus* stock also has been moderately fertile, even though it is considerably inbred, and offspring have been produced in 16 out of 36 matings.

All the stocks of *truei* are interfertile, so far as the tests have been conclusive. In 4 matings between stocks from Mesa de Maya and from Deadman Flat, 2 pairs produced together 18 young. The F_1 hybrids between these stocks were fertile when mated together, 2 matings being successful. One mating was made between the stocks from Mesa de Maya and from Highrolls, but no young were produced. Matings between the stocks from Deadman Flat and from Highrolls gave poor results, only 1 pair out of 7 pairs mated producing young. Only 1 pair of the F_1 hybrids was mated, and it failed to produce any young. As only about half the matings of *truei* within the stocks are successful, the failure of some matings does not prove infertility for the attempted crosses. In all the crosses between the stocks of *truei* where 4 or more pairs were mated offspring were produced by 1 or more of the pairs.

Interspecific crosses of *griseus* from the Tularosa Malpais with *truei* from the Mesa de Maya and from Deadman Flat have also produced young. In 5 matings between the Malpais and the Mesa de Maya stocks, 2 pairs each produced 1 young, the hybrids being 1 female and 1 male. In 12 matings between the Malpais and Deadman Flat stocks only 1 mating was successful and this produced a total of 12 female and 6 male young. In all 3 of the successful matings between *truei* and *griseus* the mother was a *truei*. This, however, may not be of any significance because numerous other matings between *truei* females and *griseus* males were unsuccessful.

The sex distribution of the F_1 hybrids, 13 females to 7 males, does not differ from the expected 10 ♀ : 10 ♂ by a significant amount. The standard error of random sampling for these numbers is $\pm$ 2.24 mice, and the deviation from the expected number of either sex is only 3.0 individuals.

The number of young in the F_1 hybrid litters varies from 1 to 4 and the average per litter is 2.22. This is somewhat less than in the pure stocks of *truei* and *griseus*. In the *griseus* Malpais stock the average number of young in 54 litters is 2.74. In *truei* the average number of young in 43 litters of the Mesa de Maya stock is 3.05, in 26 litters of the Highrolls stock is 2.69, and in 43 litters of the Deadman Flat stock is 2.81. With records available for only 9 hybrid litters the evidence is not convincing that the litter size of the hybrids is reduced significantly.

Most of the *griseus-truei* F_1 hybrid females seem to be fertile. The 1 hybrid female from the cross between the Malpais and Mesa de Maya stocks produced a litter of young when mated to a male *truei* from Deadman Flat. Two of the female hybrids from the cross between the stocks from Malpais and Deadman Flat also produced young when back-crossed to Deadman Flat males, while 2 others did not. Thus 3 female F_1 hybrids out of 5 were fertile, a proportion close to that of the parent stocks.

On the contrary, the male F_1 hybrids between *griseus* and *truei* have proved uniformly sterile, both when mated to the hybrid females and when back-crossed to either parent stock. A male F_1 hybrid between the Malpais and Mesa de Maya stocks was mated at different times, for periods each of several months' duration, with 1 female from Mesa de Maya, 1 from the Malpais, and 2 from Deadman Flat, and no young were produced in any of these matings. Four male hybrids between the stocks from Malpais and Deadman Flat were mated with 4 different females from the Malpais, and with 1 female from Deadman Flat, and no young were produced. A number of unsuccessful matings were also made between male and female F_1 hybrids and in one of these matings a female hybrid which had been proved fertile in a back-cross was used. No young were produced in any mating in which the male was a *griseus-truei* hybrid.

In addition to the matings which were made by keeping a hybrid male in a cage with a female for several months, a number of matings were made between hybrid males and females which were in estrum. The time of estrum was determined by vaginal smears following the technic of Clark (1936: 1–2). The female in estrum was placed for a period of 24 hours or more with the male to be tested, and the pair was left together until the female had reached diestrum. Vaginal smears were made of these mated females every 24 hours, and the smears were examined under a microscope to determine whether or not spermatozoa were present.

A male hybrid between stocks from the Malpais and Mesa de Maya was tested 15 different times with 7 different females of *griseus, truei,* and their F_1 hybrids, all of which were in estrum. No spermatozoa were found in the vaginas of any of the females, and no pregnancies developed. A male hybrid between the stocks from the Malpais and Deadman Flat was tested 11 times with 8 different females, also with negative results. Two other male hybrids between these stocks were tested, 1 only once, the other 6 times with 5 different females. In none of these matings were spermatozoa found in the vaginal smears nor were any young produced.

The testes of the male hybrids have always occupied an abdominal position. During all the frequent handling of these animals, the testes at no time have been located in the scrotum. It has been shown by Moore (1926: 6–12) that generally in mammals active spermatozoa are produced only when the testes are located in the scrotum. However, a male *griseus* 92 weeks of age had the testes in the abdomen when killed, and when sectioned and stained, active spermatogenesis in the testes was evident. It is known that these mice are able to move the testes rapidly from a position in the scrotum to the abdomen, and the reverse, and it is possible that the testes might have been in the scrotum of the mouse during some hours or days previously. On the other hand, the constant abdominal position of the testes in the male hybrids indicates that these hybrids are at least not very active sexually.

To determine whether or not spermatogenesis might be occurring in the testes of the hybrids, a male hybrid between the stocks from the Malpais and Mesa de Maya was killed on April 22, 1936. This male was then 149 weeks of age. No spermatozoa were present in the epididymis. A part of a testis was sectioned and stained, and under the microscope no cells undergoing spermatogenesis could be found.

Two other male hybrids between the stocks from the Malpais and Deadman Flat were killed on July 7, 1936, when they were aged respectively 52 and 30 weeks. No spermatozoa were present in the epididymis of either male.

For controls the testes of two males from the Malpais were also sectioned and stained in May. One of these males had the testes in the abdomen, as stated above, the other had the testes in the scrotum. In both males spermatozoa were present in great number in the epididymis, and in the testes of both animals spermatogenesis was in progress. A male *truei* from the Mesa de Maya was killed in April and in this animal, which had the testes in the scrotum, spermatozoa were abundant in the epididymis.

Although spermatogenesis is absent in the testes of the hybrids, the testes themselves are not much smaller than those of sexually active males. Thus the testes of 3 hybrids were respectively 9.4 and 9.1, 10.8 and 10.2, 8.1 and 7.4 mm. in length, the measurement of the left testis being given first. Corresponding measurements of two sexually active *griseus* are 11.2 and 11.5, 10.7 and 9.9 mm., and of a sexually active *truei* from Mesa de Maya, 10.2 and 8.0 mm.

The evidence seems complete that the male hybrids between *truei* and *griseus* are completely sterile, by reason of the failure of spermatogenesis.

CONCLUSIONS

It has been shown above that hybrids between *Peromyscus nasutus griseus* from the Tularosa Malpais of New Mexico and various stocks of *P. truei truei* from the Southwest can be produced, although the proportion of successful hybrid matings is low. Female hybrids are more numerous than male hybrids, although the deviation from the normal sex ratio is not significant for the relatively few hybrids produced. The female interspecific hybrids are fertile when back-crossed to either of the parent stocks. The male hybrids, on the contrary, have been uniformly sterile. Microscopical examination of the testes of the male hybrids shows that spermatogenesis is lacking.

The partial infertility which exists between the closely related forms *Peromyscus nasutus griseus* and *P. truei truei* is undoubtedly a stage in speciation. That these two forms must have descended from a common ancestor is shown both by their morphological similarities and by their fertility relationships. At the present time the two forms have diverged sufficiently to be only partially fertile together. The theoretical next step, to be reached at some time in the future, is sterility of the female hybrids as well as of the males.

LITERATURE CITED

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